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(54) **Internal mixer for the processing of rubber mixtures or rubber-like polymeric mixtures and process for the mixing of rubber mixtures or rubber-like polymeric mixtures in the internal mixer**

(57) Internal mixer for the processing of rubber mixtures or rubber-like polymeric mixtures,

- with a mixing chamber delimited by a casing,
- with two rotors which are aligned essentially parallel to each other inside the mixing chamber,
- with a feeding opening disposed essentially in the middle between the two rotors
- with a plunger movable in the feeding opening to open and close the feeding opening
- wherein, in a cross section essentially perpendicular to the rotating axes of the rotors and with the chamber in a closed position, the profile of the front surface of the plunger directed towards the chamber is shaped in such a manner that

from the outer portion of said front surface towards the center of the plunger it defines a concave shape directed away from the chamber

and the edges of the front surface define an angle α bigger than or equal to 0° with the line connecting the edges.

The invention concerns an internal mixer for the processing of rubber mixtures or rubber-like polymeric mixtures with a mixing chamber delimited by a casing, with two rotors which are aligned essentially parallel to each other inside the mixing chamber, with a feeding opening substantially centrally disposed between the two rotating axes of the two rotors and with a plunger movable in the feeding opening to open and close the feeding opening. The invention concerns also a process for mixing rubber mixtures or rubber-like polymeric mixtures in an internal mixer with at least two parallel rotors for mixing, where material for the mixture is filled in from above through a feeding opening disposed in the middle between the shafts of the rotors and where the chamber can be closed with a movable plunger placed in the feeding opening and where the rubber mixtures or rubber-like polymeric mixtures are then mixed inside the internal mixer by rotation of the rotors.

Normally, the inner profile of the mixing chambers of such internal mixers substantially fits with the profile of the external surface that is described by the outer radii of the rotors during the mixing, so that the rubber or rubber-like polymeric material is reliably transported and mixed by the rotors during their rotation. Therefore the inner profiles of such internal mixers are shaped in such a manner, as illustrated in figures 1 and 2, that they occupy the external surface of two cylinder-shaped chambers contacting or intersecting each others, wherein each cylinder is essentially concentric to one of the rotors. It is known to feed such internal mixers, made by two parallel rotor shafts which are disposed essentially horizontally one beside the other, with mixing material and additives through a feeding channel which is disposed essentially in the middle between the two rotor shafts above the rotors and which leads from the internal of the chamber through the casing to the outside. To guarantee an optimal distribution of the feeding material over the whole length of the rotors, such feeding openings are disposed essentially parallel to the rotors over the whole length of the chamber. With the help of a plunger, movable up and down in the feeding opening, the material, after being filled in, is pressed inside the chamber.

With the plunger in a closed position the front surface of the plunger directed towards the chamber describes normally essentially the continuation of the inner profile of the chamber, so that it bridges the gap in the casing created by the feeding opening, completing the cylindrical surfaces contacting or intersecting each other and so forming the chamber. For the fact that the feeding opening and the plunger of such internal mixers are disposed in the middle between the two rotor shafts, the front surface of such plunger directed towards the chamber is shaped, in its cross section perpendicular to the rotor shafts, in such manner that the profile rises steadily from the edges of said cross-section profile towards the center of the plunger. That means that the whole profile line is placed below the line connecting the edges and creates, as shown in figures 1 and 2, a single convex nose directed towards the internal mixer where, similar to a sinus curve, the edges of the plunger represent neighboring minima and the center of the plunger the maximum lying in between.

With a completely closed plunger, the conventional plungers with such a profile enable, in principle, a very satisfactory mixing result because, also the material placed below the plunger, that has to be mixed inside the chamber, is reliably captured and mixed by the rotors which brush against the chamber walls formed by the chamber itself and by the plunger and which are adapted perfectly to the external curved surface of the rotors.

The time concerned with the mixing cycle, from the start of the mixing to the completion of the mixing process is composed of a feeding phase and a mixing phase. During the feeding phase, mixing material is filled in and the plunger is closed as far as possible by hydraulic or pneumatic force. The material which is not yet mixed causes such a big pressure on the plunger that the plunger cannot yet be completely closed. After a preliminary mixing of the mixture materials by rotation of the rotors, with the plunger consequently not completely closed, the plunger is removed. After removing the plunger, other additives are added to the mixture according to the requirements of the mixture, for instance accelerators to a rubber mixture for tires. Afterwards, the plunger is closed as far as possible, but normally the plunger cannot yet be closed completely. During the following mixing process the temperature and the pressure in the chamber are normally rising, so that the plunger is initially lifted further up inside the feeding opening because of the high pressure. Only after further mixing in the chamber the plunger is slowly lowered, because of the sinking inner pressure, until it reaches its closed position. Only when the plunger has reached its closed position, the feeding phase is completed. For the majority of the conventional mixtures the feeding phase represents the majority of the whole time concerned with the mixing cycle. Only afterwards, in a relative short time for completing the mixing, the plunger is completely closed and the profile outline of the plunger and the cylindrical chamber wall form a chamber profile essentially closed and adapted to the movement's profile of the external radii of both rotors, so that the rubber material or rubber-like material and the additives, placed below the plunger, are reliably captured. The advantages of the profiles of such plungers become apparent only in that late phase of the mixing cycle.

During the previous long feeding phase, when the plunger is not completely closed, dead and non active zones, where no mixing takes place, are formed on the edges and on the walls of the feeding channel. This because the profile rises constantly from the edges towards the center of the plunger inwardly to the chamber, on the front surface of the plunger directed towards the chamber taken in a cross section perpendicular to the rotor shafts, thus creating acute angles between that profile and the feeding channel wall. This has the consequence that, after the whole long feeding phase when the plunger is not completely closed, the rubber material or rubber-like material and the additives collected below the plunger in the feeding channel on the edges of the plunger are nearly not mixed. All these unmixed materials shall be so completely mixed with the rest of the material during the short period which is left for the actual mixing, for obtaining a uniform quality of the mixture.

As a result, at least for problematic mixtures, either the remaining mixing phase is not sufficient for a complete mixing, therefore affecting the quality of the mixture, or the mixing phase, and consequently the whole period necessary for the mixing cycle, has to be prolonged appropriately. For instance, it is know that addition of zinc oxide to the rubber mixture may cause accumulations in the mixture, that needs thus to be re-mixed. These accumulations can arise also with other filling materials, depending on the hardness of the grain.

An increase of the whole period of the cycle means a bad use of the capacity of the internal mixers and an additional expense for the maintaining the production level, for the maintenance and the installation, for further space to install the internal mixers and therefore an increase of the production costs of the production costs.

In DE-PS 26 16 338 C2 an internal mixer is graphically presented, where the plunger presents a flat, non shaped front surface. Because of the orthogonal arrangement of the non shaped front surface with respect to the side walls of the feeding opening when the plunger is not closed also such a profile have as a result substantial dead zones at the edges of the plunger where there is no mixing when the plunger is not closed.

The invention relates to the objective of providing an internal mixer and a respective process which allow to obtain a better mixing of the materials to be mixed, placed below the edges of the non closed plunger.

This objective is achieved, according to the invention by the provision of an internal mixer according to the features of claim 1 as well as of a process according to the features of claim 8.

The provision of a front surface, with a profile that starting from the edges defines a concave shape directed away from the chamber in a cross section perpendicular to the axes of the rotors and with an increase of the profile line of an angle $\alpha >= 0°$ with respect to the line connecting the edges of the plunger, results in the mixing material not being pressed in the acute corners below the edges of the plunger, as with the profile of the conventional plunger adapted to the profile of the chamber. This profile has been designed in order to enable the creation of stream lines, which reach substantially the edge zone and enable, because of the essentially obtuse angle between the side wall and the profile of the plunger, the transport of the material along the profile of the side wall of the feeding channel into the internal of the mixer, as a result of the suction effect generated by the internal mixer.

Because of the shape of the plunger when the plunger is half closed, the mixture is mixed by the rotation of the rotors also in the edge zones of the plunger, in the feeding space above the rotors. As a result of the early mixing also in the edge zones of the plunger, the pressure created during non completed mixing which lifts the plunger upwards is reduced earlier and the feeding phase is accordingly reduced. The plunger thus reaches earlier its closed position. In this way, the portion of time for the subsequent mixing inside the internal mixer with the closed plunger increases within a given period for the complete mixing cycle.

As a mixing takes place already during the feeding phase also in the edge zones of the plunger, the mixture is already better mixed at the end of the feeding phase, i.e. when the plunger reaches its closed position, so that a better mixing takes place also during the feeding phase. The whole time being at disposal for the effective mixing is thus also increased.

Because of the increase of the effective mixing phase, it is possible to reduce the period of the cycle or to guarantee a higher mixing quality with a constant cycle period.

The provision of the internal mixer according to the features of claim 2 represents a simple form of such an internal mixer which highly prevents the creation of inactive dead zones in the edge zones of the plunger.

It is preferable an embodiment according to the features of claim 3 where, in the edge zones, the advantages of the concave profile outline - with a raising line of α bigger than or equal 0° with respect to the line connecting the edges, for the creation of an edge zone with nearly no dead zone – are combined with an optimal convex plunger profile which follows essentially the shape of the external surface that is described by the outer radii of the rotors during the mixing, when the plunger is in the closed position. The convex nose guarantees, in a closed position, a conveyance of the material placed below the plunger. In addition, the convex nose makes it possible, also with the open plunger, that the mixing material, which is moved in the edge zones along stream lines following the concave profile of the internal mixer, is also moved from the middle zone of the plunger nearly without dead zones along the stream lines of the wall of the feeding channel, following the concave profile in the edge zone and the convex profile of the nose, into the internal of the mixer and mixed.

Thus, with the plunger not completely closed, i.e. before the whole feeding phase terminates, an even more reliable mixing of the material present below the plunger with the material being in the zone of the rotors can be achieved. The shaping according to the features of claim 4 represents an optimized edge profile outline of the plunger. The obtuse angle, which is formed by the edge profile and the side wall below the plunger, enables an optimal conveyance and mixing of the mixing material.

The embodiment according to the features of claim 5 represents a preferred form of the internal mixer, because the feeding process is carried out very easily, like in conventional internal mixers, already by the weight of the mixture components and the additives and of the plunger.

The embodiment according to the features of claim 6 makes it possible that the effective mixing phase is additionally increased. As in conventional internal mixers a removable discharge drop door is created in the casing, in the middle and below the rotor shafts. The concave shape of the drop door, directed towards the chamber, with an obtuse intersecting angle formed by the tangents originated on the edge points and directed towards the concave profile, creates additional space for holding the material filled in through the feeding opening. The plunger placed in the feeding opening can thus reach the closed position even earlier. As usual, the direction of the rotation of the two rotors is such that in between the rotors they

rotate from up to down. The material filled in, when moving down to reach the drop door, needs to penetrate the zone of the rotors once, so that it is subjected to the first mixing by the rotating movement of the rotors. The profile of the drop door enables the material transported into and collected in the concave space to be dragged, by the rotation movement of the rotors, along the concave profile in the moving direction of the rotors into a gap which is formed by the profile of the drop door and the rotors. This dragging movement causes a nearly complete conveyance of the material that has to be mixed and a mixing even at the first rotation of the rotors. In that way an effective mixing begins very early already during the feeding phase, taking place right on the first rotation of the rotors.

Realizing the internal mixer according to the features of claim 7, the wedge effect between internal mixer and the profile of the drop door is further improved so that the dragging of the material from the drop door is even more facilitated.

The invention will be explained more in detail with the help of the exemplifying embodiments illustrated diagrammatically in the figures 1 - 9.

Figure 1 Known internal mixer with the plunger partially opened, illustrated in a cross section perpendicular to the rotors

Figure 2 Known internal mixer according to figure 1, but with the plunger completely closed

Figure 3 Internal mixer with plunger according to the invention in its first version in partially closed position

Figure 4 Internal mixer according to figure 3 with the plunger completely closed

Figure 5 Internal mixer with the plunger according to the invention in the second version in closed position

Figure 6 Internal mixer with the plunger according to the invention in the third version in closed position

Figure 7 Diagram for the illustration of the changing of position of the plunger during the mixing cycle

Figure 8 Internal mixer according to the exemplifying embodiment of figure 5 with modified profile of the drop door

Figure 9 Internal mixer according to figure 8 with further version of the profile of the drop door.

Each of figures 1 to 6, figure 8 and figure 9 shows an internal mixer with two parallel rotors 10 and 11, respectively, arranged in an horizontal plane, which respective paddles 14 and 15 intersect each other in their rotation movement. The rotors 10 and 11 are mounted in a known manner on a pivot with their shafts 12 and 13 inside a mixing casing 1. The paddles 14 and 15 of the rotors are extending along the rotor shafts 12 and 13, respectively, over the whole length of the mixing chamber. With their outer radii the paddles 14 and 15 describe

external cylinder surfaces, which intersect in the intersecting zone of the rotor paddles 14 and 15 in the middle between the rotor shafts 12 and 13. The profile of the inner chamber wall 2 is adapted to the external cylinder surfaces described by the external radii of the rotor paddles 14 and 15. The left chamber wall 3 suitably forms a portion of an external surface of a cylinder, which is disposed concentrically to the rotation axis of the rotor shaft 12. The right chamber wall 4 forms a corresponding portion of an external surface of a cylinder which is disposed concentrically to the rotation axis of the rotor shaft 13. A feeding channel 5, with parallel feeding channel walls 6 and 7, is disposed in a known manner, in the mixing casing 1, above the rotors 10 and 11, respectively, in the middle between the axes of the rotor shafts 12 and 13, respectively. A plunger 8, perpendicularly movable to the plane through the axes of the rotor shafts 12 and 13, is placed in this channel.

A discharge channel, axially parallel to the rotor shafts 12 and 13 and extending over the whole length of the mixing chamber, like the feeding channel 5, is built, in a known manner, below the rotors 10 and 11 in the mixing casing 1, symmetrically in the middle between the rotation axes of the rotor shafts 12 and 13. A drop door 17, is placed, in a known manner, inside the discharging channel.

For the mixing, the rotors 10 and 11 are powered in a known manner, in such a way that their paddles 14 and 15 are moving from up to down between the rotor shafts 12 and 13.

Figure 1 and 2 represent a conventional version, belonging to the actual state of the art, of the internal profile 18 of the plunger 8 and of the internal profile of the drop door 17. A coordinate system is shown in the cross section illustration, on each of the respective edge points 28 and 29 of the profile of the plunger directed towards the side walls 6 and 7 of the feeding channel, to explain the outline of the profile. In the edge point 28 the coordinate system is marked with the sign L and in the right edge point 29 with the sign R. The two x-coordinates x_L and x_R are directed in the moving direction of the plunger, away from the internal of the chamber, and the perpendicular axis of the y-coordinates is directed from the correspondent edge point 28 and 29, respectively, towards the center of the plunger.

As shown in figure 2, the internal profile of the plunger 18 and of the drop door 17 of conventional plungers [and drop doors] are shaped in a way that they form, with the plunger 8 and the drop door 17 in a closed position, each the continuation of the external cylinder surface formed by the left portion of chamber wall 3 and the right portion of chamber wall 4. The external cylinder surface 18 is symmetric with the line parallel with the x-coordinate and located in the center of the two plunger edges 28 and 29. The drop door 17, similarly, is symmetrical in its left profile 23 and its right profile 24, between the edges 30 and 31.

The description of the profile outlines is limited, therefore, in the following to the description of the only left profile outline 20 of the plunger and 23 of the drop door, respectively. The profile outlines 20 and 23, respectively, raise already from the edge points 28 and 30, respectively, towards the center of the plunger 8 and the drop door 17, respectively, towards the mixing chamber 9, generating an angle α at the plunger and an

angle β at the drop door. This outline raises steadily and flattens only in the center area between the edges 28 and 29 and, respectively, 30 and 31, where the left profile outline 20 comes into contact with the right profile outline 21 and, respectively, 23 comes into contact with 24, thus forming the respective noses 22 and 25 directed towards the mixing chamber 9. The profiles 18 and 19 are thus each completely developed below the connecting lines 27 and 50, respectively, on the side towards the mixing chamber 9. The profile outline 18 of the plunger has completely negative x-coordinate values.

As shown in figure 2, when the plunger and the drop door are closed, the plunger 8 and the drop door 17 form, together with the chamber walls 3 and 4, an external shape which corresponds essentially to the external curved surface of two intersecting cylinders, which cylinder axes coincidence with the rotation shafts of the rotors 12 and 13.

In a completely closed position, like in figure 2, the rubber mixing material inside the mixing chamber 9 is captured from the rotor paddles and mixed completely by rotating the rotors

In figure 7, the movement of the plunger 8 during a mixing cycle is schematically depicted. The plunger is first lifted to feed the internal mixer. The feeding phase 34 in the movement diagram 30 corresponds to a maximum plateau. The plunger is pushed down at the moment t0, which indicates the beginning of the mixing cycle, pressing the rubber mixing material downwards into the catchment area of the rotor paddles 14 and 15. During the following mixing phase, the plunger does not reach a completely closed position as a result of the lacking mixing, the amount of hollow spaces and the possible incomplete diffusion of the mixture at that moment. The plunger presents a lifted level 35 which decreases slowly. At a moment t1, the plunger is lifted to the level 36 to add more additives of a known kind, for instance zinc oxide. Afterwards, the plunger is pushed down for closing and, at the moment t2, mixing continues. Because of the development of heat and pressure in the mixing chamber during the mixing, the plunger is lifted far up until it reaches a maximum 37 in the moment t3. During further mixing the plunger slowly sinks, reaching the closed position in the moment t4, as represented in figure 2. The plunger remains in this position essentially until the final moment t5 of the mixing cycle 31. Afterwards, the drop door 17 is opened, for instance by lowering it, and the chamber is discharged in a known way.

As shown in figure 7, the feeding phase 32, lying between the moments t0 and t4, is very large in comparison to the following mixing phase 33 where the plunger is completely closed as shown in figure 2. The feeding phase takes, for instance, between a third and three quarters of the time concerned with the mixing cycle.

With the plunger not completely closed, as shown in figure 1, the mixing material below the plunger can be transported by the rotors 14 and 15 along the stream lines represented by arrows. Thus, the material placed directly below the point of the plunger can be captured by the rotors 10 and 11 and transported into the mixing chamber 9. Dead inactive zones 26 are present at the edge zones of the plunger. The material in these inactive dead zones is neither

mixed inside the feeding channel nor transported into the chamber to be mixed there. Only with the plunger completely closed, according to figure 2, the material is captured by the rotor paddles and mixed. Only a short period is left for the effective mixing phase 33 concerned with the complete mixing of the rubber material and of the additives accumulated in the dead zones 26.

Figure 3 represents an exemplifying embodiment according to the invention, where the chamber is created by a plunger 8, whose front surface directed towards the mixing chamber 9 shows a concave plunger profile 38 in a cross section. The concave shape is extended over the whole length of the cross section between the edges 28 and 29. In the examples of the figures 3 and 4, the concave curve is represented by a profile outline 38, which is a circular section lying between the edge points 28 and 29 with a curve radius R2. The center of the curve radius R2 lies on the intermediate perpendicular line between the axes of the rotor shafts 12 and 13. The curve radius R2 corresponds to the radius R1 of the inner profile of the chamber wall sections 3 and 4 around the axes of the rotor shafts 12 and 13. As shown in figure 3, the profile 38 is symmetric with respect to a straight intermediate line parallel to the x-axes x_R and x_L between the edges 28 and 29. The further description is, also here, limited to the left profile outline in the left coordinate system. Already in the edge zone 28, the profile outline 38 raises defining an angle $\alpha > 0°$ with the connecting line 27, with an x-value increasing continuously in the y-direction and an then flattening until reaching the center between the edges 28 and 29. As a result of this, the angle between the side wall 6, below the plunger, and the curve 38 at the edge 28, is an obtuse angle. As shown in figure 3, the rotor paddles 14 and 15 drag the mixture and additives, captured below the plunger, also when the plunger is not completely closed, along the stream lines (represented schematically with arrows) following the profile 38 of the plunger from the edge zones 28 and 29 to the center of the plunger and from there to the mixing chamber 9. The obtuse angle of the side walls 6 and 7, respectively, below the plunger with the profile 38 at the edges 28 and 29 together with the concave profile outline of the plunger 8 have as a result that the mixing material and the additives, placed below the plunger, are dragged into the mixing circulatory also when the plunger 8 is not completely closed. This means that, as shown in the representation of the movement of figure 7, the mixing material placed below the plunger edges is mixed already in the feeding phase 32 in the periods 35 and 37, so that the majority of the mixing cycle is used for the mixing. For the fact that the mixing material placed below the plunger is mixed earlier, also the relaxing phase of the period 37 begins earlier in a way that the feeding phase ends earlier.

Figure 5 shows an internal mixer with the plunger 8 in closed position which is formed, alternatively, with another profile outline according to the invention. Contrary to the plunger of the figures 3 and 4, the profile, being otherwise similar, in the zone of the intermediate line between the edges 28 and 29 takes the shape of a nose 42 directed towards the mixing chamber. The profile is composed in the edge zones of a left profile outline 40 and a right profile outline 41, each taking a third of the whole profile line, which are essentially

corresponding to the profile outline of the exemplifying embodiments of figures 3 and 4, respectively, having a curve radius R2. In the central third, the profile is curved towards the inside of the chamber with a curve radius R3 and with the curve center disposed between profile and connecting line 27, thus forming the nose 42. The plunger 8, according to the version of figure 5, has generally a concave profile outline, where also the curved zones between the point of the nose and the edges create concave plunger profile outlines.

In the exemplifying embodiment of figure 6 the point of the nose 45, differently from the exemplifying embodiment of figure 5, is further projecting towards the chamber. Also here it is shown that the left profile outline 43 and the right profile outline 44 represent a concave form each from the edges 28 and 29 until nearly the middle of the plunger and that the nose 45 is formed only in the central third **d** of the distance **b** between the edges 28 and 29. It is conceivable to extend the nose 45 so far into the internal of the mixing chamber that the nose 45, with the plunger closed, contacts a radius R5 around the rotation axes of the rotor shafts which is at least as long as radius R1 of the mixing chamber wall sections 3 and respectively 4, to guarantee that the rotor paddles can pass by with the plunger closed. The profile outline of the exemplifying embodiments of the figures 5 and 6 enables a conveyance of the mixing material on the edges 28 and 29 along the profile of the plunger, also when the plunger is not completely closed, leading the material through the plunger profile in the sure catchment area of the rotors. It is sensible to extend the nose at most for a distance **e** over the connecting line between the edges 28 and 29. This distance **e** occupies about 1/3 of the distance **c**, being **c** the distance between the intersecting point of the two radii R5 and the connecting line, in a way that both streams of material can be mixed already above the rotors.

Depending from the individual requests for each internal mixer and for the rubber mixtures it is possible to shape the nose individually in its profile outline in a way that, through such a development can be prevented, if necessary, the creation of inactive zones in the middle of the plunger when the plunger is not completely closed.

In the exemplifying embodiment of figure 8, the shape of the front surface of the drop door 17 directed towards the internal of the chamber is concave, with a profile 46 representing a circle section of a radius R6 with the center point on the intermediate perpendicular line between the axes of the rotor shafts 12 and 13. The radius R6 is equal to radius R1. The profile 46 comprises in each of the edge zones 30 and 31 an angle β with the connecting line 50, said profile 46 presenting a continuous slope from the edges 30 and 31 to the center of the drop door. Above the drop door 17, for the concave shape, additional space is created between the curve surfaces described by the rotor paddles during rotation in the form of external cylinder surfaces and the profile 46, where the mixing material fed into the mixing chamber can sink down. Therefore, plunger 8 reaches its closed position earlier. The special concave shape of the front surface of the drop door with the profile 46 creates with the paddles 14 and 15 of the rotors a wedge shaped gap. Because of that wedge shaped the material placed

between the profile 46 and the rotor paddles is transported along the profile 46 by the rotating rotor paddles to be mixed.

Figure 9 shows a further version of the drop door profile 47, where, in correspondence with the plunger profile in figure 5, the drop door is formed by a left concave profile 47 and a right concave profile 48 and a nose 49 in between, which is extended at most for the central third of the drop door extension between the edges 30 and 31. The rubber material, filled in from above, is pushed along the nose over the curve of the nose (with the curve radius R8) and over the curves of the edge zones 47 and 48 (with curve radius R6) and dragged by the rotor paddles along the wedge shaped gap near the edges 30 and 31. Also here the drop door has generally a concave shape. Only in the narrow central area of the drop door there is a nose. In addition, two concave zones, each extending from the edges to the nose, are formed in the two lateral zones 47 and 48.

Even if each drop door profile in figure 8 and figure 9 is illustrated in connection with the plunger profile of figure 5, such a drop door profile version is possible also in connection with another illustrated exemplifying embodiment of the plunger profile.

In any case it is conceivable that the angle α of the profile at the edges of the plunger is of zero degrees and that the corresponding inner profile 38 and 39 of the plunger from each side towards the middle has an increasing angle α and a concave shape, in all exemplifying embodiments according to the invention. Similarly it is conceivable that the angle β in the edge zones of the drop door 17 at the edges 30 and 31 is of zero degrees and that the profile raises from the edges 30 and 31 towards the drop door center with an increasing angle β and a concave in the exemplifying embodiments of figures 8 and 9.

The internal mixer can also be a tangent mixer where the rotor paddles do not intersect each other in their movements.

The drive for moving the plunger can be hydraulic, pneumatic or in any other suitable manner.

The rotor shafts 11 and 12 can be made from one continuous shaft or from two concentric shaft pins which are separated in their longitudinal direction.

List of the signs of reference

1 casing of the chamber of the internal mixer
2 inner chamber wall
3 chamber wall section
4 chamber wall section
5 feeding channel
6 wall
7 wall
8 plunger
9 mixing chamber
10 mixing rotor
11 mixing rotor
12 rotor shaft
13 rotor shaft
14 rotor paddle
15 rotor paddle
16 opening for discharge
17 drop door for discharge
18 internal profile of the plunger
19 internal profile of the drop door
20 left profile outline
21 right profile outline
22 nose
23 left profile outline
24 right profile outline
25 nose
26 dead zone
27 connecting line
28 edge
29 edge
30 movement diagram
31 mixing cycle
32 feeding phase
33 mixing phase
34 feeding
35 mixing
36 addition
37 mixing

38 internal profile of the plunger
39 internal profile of the plunger
40 left profile outline
41 right profile outline
42 nose
43 left profile outline
44 right profile outline
45 nose
46 internal profile of the drop door
47 left edge
48 right edge
49 nose
50 connecting line

Claims

1. Internal mixer for the processing of rubber mixtures or rubber-like polymeric mixtures,

- with a mixing chamber delimited by a casing,
- with two rotors which are aligned essentially parallel to each other inside the mixing chamber,
- with a feeding opening disposed essentially in the middle between the axes of the two rotors,
- with a plunger movable in the feeding opening to open and close the feeding opening,
- wherein, in a cross section essentially perpendicular to the rotating axes of the rotors and with the chamber in a closed position, the profile of the front surface of the plunger directed towards the chamber is shaped in such a manner
  that from the outer portion of said front surface towards the center of the plunger it defines a concave shape directed away from the chamber
  and the edges of the front surface define an angle α bigger than or equal to 0° with the line connecting the edges.

2. Internal mixer according to the features of claim 1

- wherein, in a cross section essentially perpendicular to the rotating axes of the rotors and with the chamber in a closed position, the profile of the front surface of the plunger directed towards the chamber is shaped in such a manner that from the two edges towards the center of the plunger, it defines a concave shape directed away from the

chamber extending from one edge to the other, said profile includes, at the edges, essentially an angle $\alpha > 0°$ with the line connecting the to edges, wherein the concave curve is designed particularly as a circle shaped curve around a center which lies on the intermediate perpendicular line between the rotors, wherein particularly the curve radius of said concave curve is smaller than or equal to the radii of the rotors of the internal mixer.

3. Internal mixer according to the features of claim1,

- wherein, in a cross section essentially perpendicular to the rotating axes of the rotors and with the chamber in a closed position, the profile of the front surface of the plunger directed towards the chamber is shaped in such a manner that from the two edges towards the center of the plunger, it starts defining a concave shape directed away from the chamber, wherein in the middle of the front surface of the plunger between the two concave sections said profile has a convex form, with a nose directed towards the chamber, wherein the nose extends, with the plunger closed, at most that it does not effectively contact the radii of the rotors.

4. Internal mixer according of the features of claim 3,

- wherein the angle $\alpha > 0°$.

5. Internal mixer according to the features of one or more of the previous claims,

- wherein the rotor shafts are essentially aligned one aside the other and where, particularly, the feeding opening is placed above the shafts aligned one beside the other and where the plunger is essentially perpendicular and movable up and down.

6. Internal mixer according to the features of one or more of the claims 1 to 4 and 5,

- wherein, in addition, below the rotors, essentially in the middle between the rotors, a drop door is disposed in the casing, which drop door can be moved from a closed position to an opened position and back again,
- wherein the front surface of the drop door directed towards the chamber, in a cross section perpendicular to the direction of the axes of the rotors, has the profile outlined in

a manner that from the two edges of the drop door to the center of the drop door it defines a concave shape directed away from the chamber and including, at the edges, an angle $\beta > 0°$

wherein the two tangents through the edge points of the drop door profile are intersecting on an intermediate perpendicular line between the two axes of the rotors.

7. Internal mixer according to the features of claim 6,

- wherein the angle β is bigger than 0° and the curve radius of the drop door profile is bigger than or equal to the radii of the rotors.

8. Process for mixing rubber mixtures or rubber-like polymeric mixtures in an internal mixer with at least two parallel rotor shafts for mixing,

- where, in the middle between the rotors, material is filled in through a feeding channel and where the chamber is then closed for mixing with a movable plunger in the area of the feeding channel,
- where rubber or rubber like polymeric mixtures are then mixed by rotation of the rotors,
- wherein, also with the plunger only partially closed, the mixing material placed in the feeding channel in the edge zones of the plunger is, by the rotation of the rotors, transported along the shape, because of the shape of the plunger, and therefore mixed in.

EP845339A1: Internal mixer for mixing rubber or similar compositions and a method for mixing rubber or similar compositions in the internal mixer

Mixer for rubbery materials especially used in tyre manufacture In the kneader processes rubber or similar mixtures of plastics, the mixing chamber has two parallel rotors with a filling opening centrally between their axes. A sliding plunger opens and closes this opening. When the chamber is closed, a section taken through the plunger perpendicular to the rotor axes reveals the concave guide surface(s) of its face, between both edges to the centre. At the edges of the plunger, its end face forms an angle with the line joining the edges. The angle is greater than or equal to zero. Also claimed is the method of mixing rubbery materials in a kneader, using the equipment described.